Group Project Planning Report

Select which area of interest your natural system falls under:

- Foraging
- Flocking/Swarming
- Host-parasite interactions
- Competition between species
- Disease spread and control in animal populations

What is the research question?

Is vaccination or population density more effective in controlling the rate of infection in a rabbit population with rabbit haemorrhagic disease (RHD)?

What research articles/sources have you found so far that are relevant to this?

Calvete, Carlos (2006) 'The use of immunization programs in wild populations: Modelling effectiveness of vaccination campaigns against rabbit hemorrhagic disease', Biological conservation, 130(2), pp. 290–300. doi:10.1016/j.biocon.2005.12.025.

Calvete, Carlos (2006) 'Modeling the Effect of Population Dynamics on the Impact of Rabbit Hemorrhagic Disease', Conservation biology. Paper submitted April 11, 2005; revised manuscript accepted September 6, 2005., 20(4), pp. 1232–1241. doi:10.1111/j.1523-1739.2006.00371.x.

Wells, K. et al. (2015) 'Timing and severity of immunizing diseases in rabbits is controlled by seasonal matching of host and pathogen dynamics', Journal of the Royal Society interface, 12(103), p. 20141184. doi:10.1098/rsif.2014.1184.

Fa, J. E., Sharples, C. M., Bell, D. J., & DeAngelis, D. (2001). An individual-based model of rabbit viral haemorrhagic disease in European wild rabbits (Oryctolagus cuniculus). Ecological Modelling, 144(2-3), 121-138.

Conceptual model

What are the agents in the system (their sub-classes etc)

Main class: Rabbits

Sub-classes: Newborn, juvenile, and adult. Newborns stay in warrens and do not spread the disease. Juveniles have lower mortality rates than adults with regards to RHD infection. Juvenile also cannot breed. Both juvenile and adults can contract and spread disease.

Agent properties/states

A. Age
B. Infection Status - Susceptible, Infected, and Chronically Diseased
C. Vaccination Status – Vaccinated, Not Vaccinated
D. Location – Position of agents

The rules (and their behaviours)

1. Vaccination
A vaccinated rabbit has a reduced mortality rate from the disease. Infected rabbits cannot be cured from the disease through vaccination. Therefore, vaccination status does not affect recovery rates from the disease.
To vaccinate rabbits, we randomly choose a subset from total population with the exception of newborns.

2. Reproduction
Only adults have the ability to reproduce.
Breeding season occurring during the months of October to May of the following year.
Gestation lasts 30 days. For each pair of adults, there are four newborns.

3. Non-disease related death
We assume that the mortality rate of adult rabbits is steady such that they die when they reach the maximum age of 10 years. Juvenile deaths are dependent on adult density such that when the carrying capacity of the population is reached, the death rate increases from 30% to 50%.

4. Disease related death
Infected adults have a 90% probability of death whilst juveniles have 50% probability of death.

5. Movement
Includes new borns leaving the breeding stop and the physical contact between rabbits

6. Disease transmission
Transmission occurs between rabbits when their distance equals to one unit.

7. Recovery from disease
Juveniles' recovery rate is 50% whilst adults is lower at 10%.

8. Carrying capacity
When the carrying capacity of the population is reached, the death rate among juveniles increases.

The environment

The environment is closed system such that there is no emigration/ immigration. We want to vary the initial sizes of the environment to test whether population density has an effect on infection rates.
There are no predators as we are only interested in the emergent behaviour between rabbits.
There is also a defined breeding stop where newborn rabbits live.

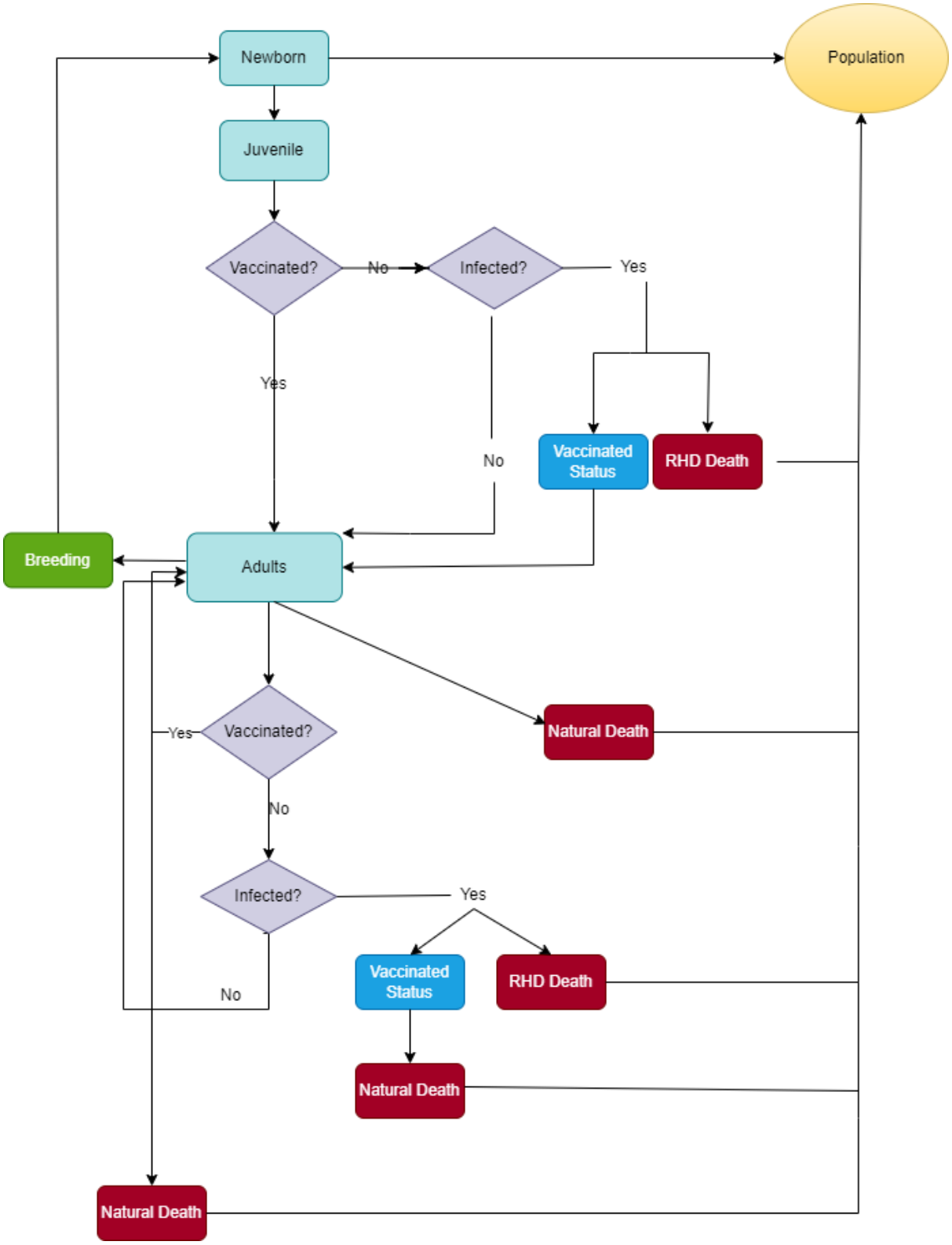
Time and length scales (resolution etc)

The smallest time step is one week. We want to simulate different durations – from a minimum of 10 years.

What emergent behaviour you will be interested in, and how it will be recorded.

We are interested in the rate of infection between the rabbits. As transmission is spatially determined, we can simulate different initializations on vaccination rates and population density. We can assign a specific colour depending on the infection status of the rabbit to visualise the spread of the disease.

Brief overview of the model design


Newborn
Population
Juvenile
Vaccinated?
No
Infected?
Yes
Yes
No
Vaccinated Status
RHD Death
Breeding
Adults
Natural Death
Yes
Vaccinated?
No
Infected?
Yes
Vaccinated Status
RHD Death
No
Natural Death
Natural Death